

Air Traffic Control Seminar

Oceanic ATC Operations

Presented by Ed Wilson
Oakland Oceanic

NASA Ames Research Center

Moffett Field, California

Sept 5-6, 2007



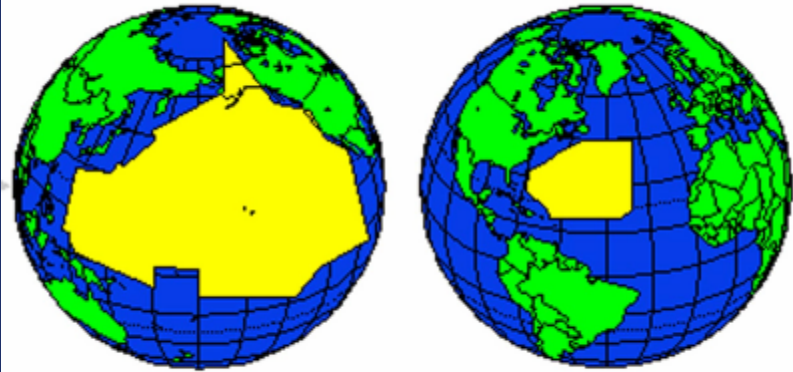
International Airspace

- **International Civil Aviation Organization (ICAO)**
 - United Nations organization
 - Determines who will provide ATC services
 - Delegates Oceanic Airspace (Flight Information Regions – FIRs)
 - North Atlantic Region
 - Caribbean Region
 - Pacific Region
 - North American Region
 - English is the universal aviation language

The Oceanic Environment

Unique Airspace with Complex Separation Standards and Coordination Rules

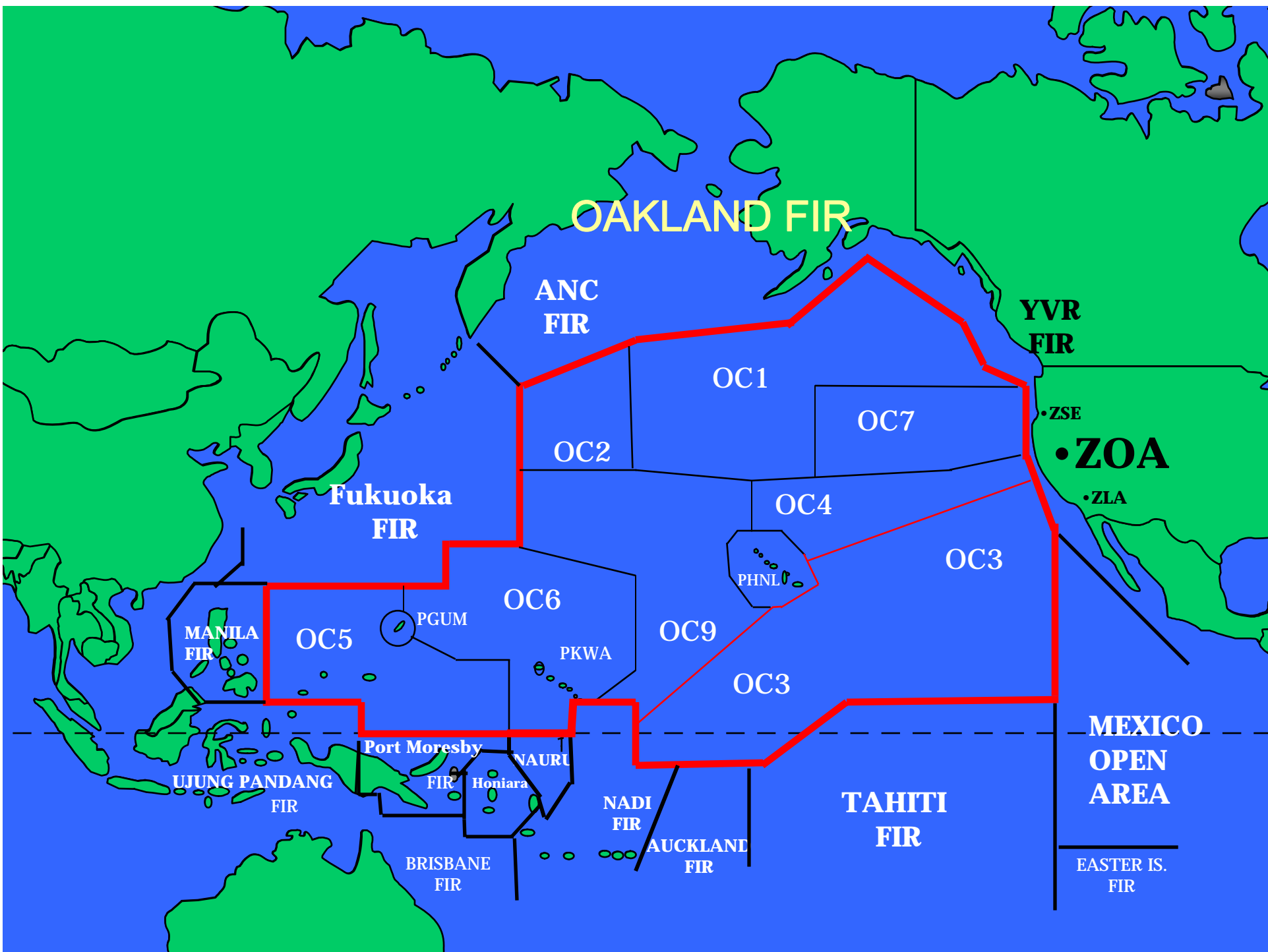
- International Civil Aviation Organization (ICAO) delegated 24M sq miles of international oceanic airspace to the US



Facility	Miles of Airspace	Flights per day
New York (ZNY)	3.3M sq miles	~500
Oakland (ZOA)	18.6M sq miles	~725
Anchorage (ZAN)	2.75M sq miles	~200

ZOA Oceanic Airspace

- **Largest oceanic airspace in the world controlled by one facility - 9.56% of world's surface**
- **Eight Oceanic Sectors and Three Coastal Radar Sectors**
- **Interface with 19 different foreign and domestic facilities**

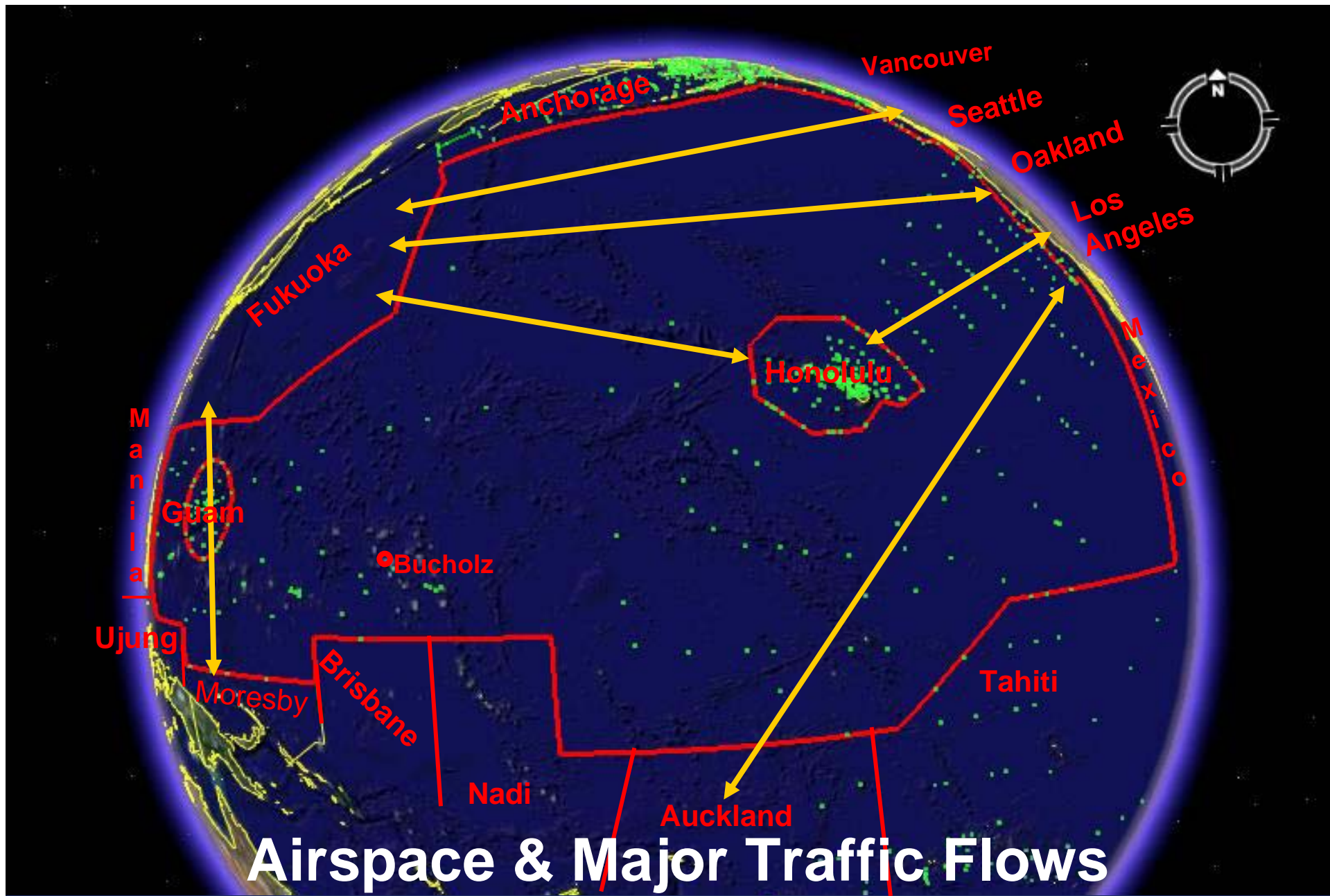


Oceanic Route Structure

- **Fixed Air Traffic Service (ATS) Routes**
- **Pacific Organized Track System (PACOTS)**
- **User Preferred Routes (UPRs) and Dynamic Airborne Reroutes**

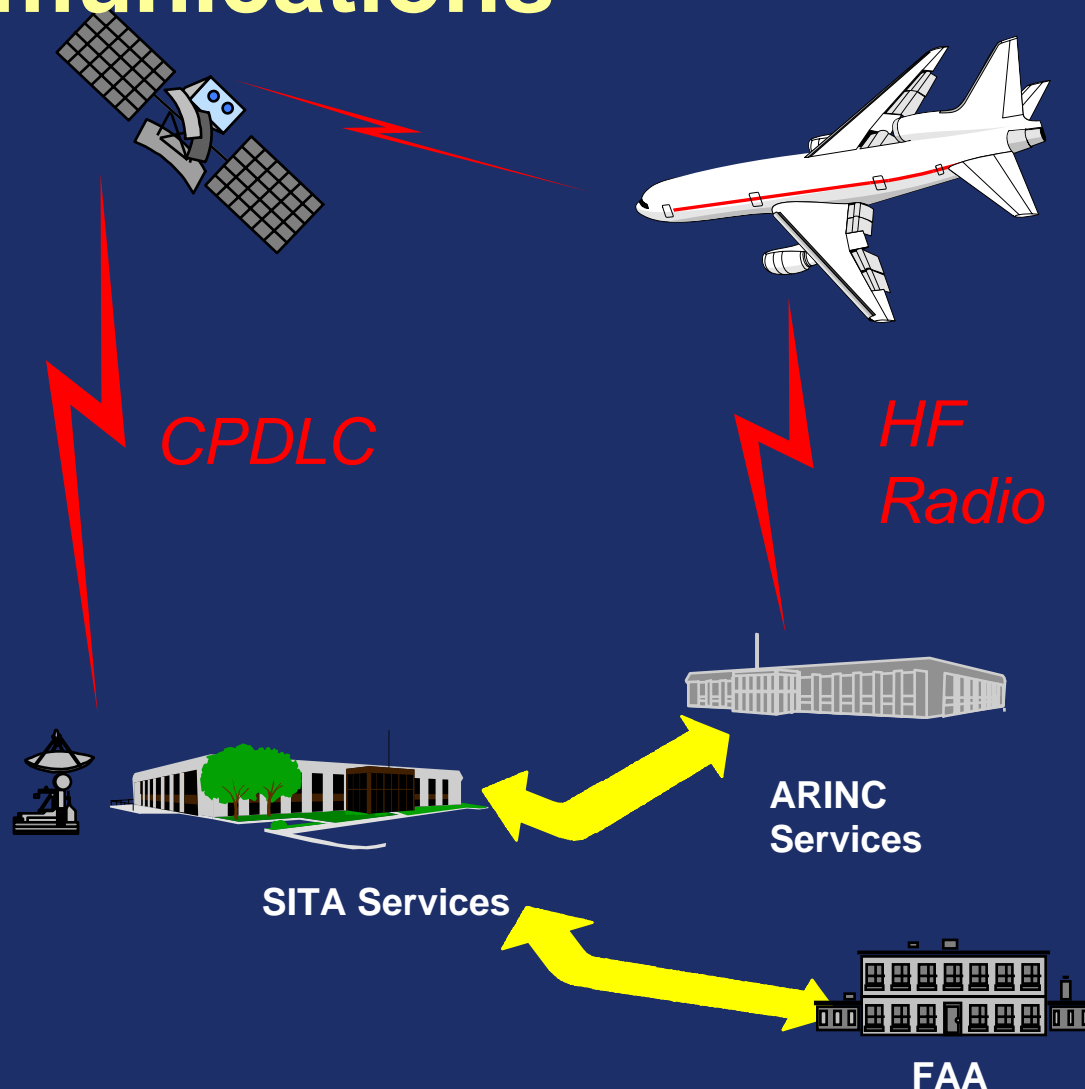
Pacific Organized Track System (PACOTS)

- **Flexible Routes Based On Forecast Upper Winds**
- **Published Twice Daily By ZOA TMU and Fukuoka Air Traffic Management Center (ATMC)**
- **FAA routes produced using Dynamic Ocean Track System (DOTS)**
- **PACOTS Benefits**
 - Reduced traffic Complexity
 - Optimum Cruise Altitudes
 - Fewer Reroutes
 - Improved Fuel Efficiency and Predictability



Data Link Communications

- Aircraft contacts Oakland Center with clearance request
- Request routed via satellite, through GES to ground-based equipment
- Oakland Center issues clearance directly to aircraft via reciprocal process



Alternate Communications

- **HF Voice**
- **Phone patch initiated by pilot or controller, facilitated through ARINC HF frequency, for direct voice communications**
- **Available to aircraft with SAT Voice communications equipment**

Oceanic Air Traffic Control

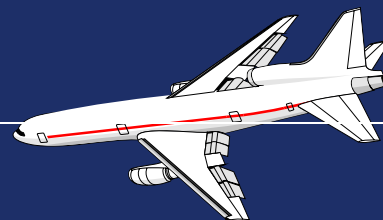
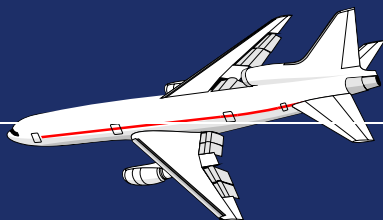
- **Manual control**
- **Visual display through computer generated tracking system**
- **Advancements driven by new technology**
- **Standard Oceanic Separation**
 - 100nm laterally
 - 15 minutes longitudinally
 - 10 minutes turbojet aircraft
 - 1000/2000 feet vertically

Reduced Vertical Separation Minima (RVSM)

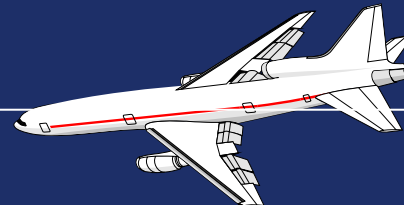
- Reduces the vertical separation minima between aircraft above F290 to 1000 feet.

(RVSM)

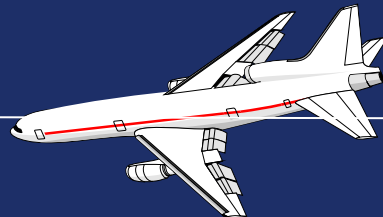
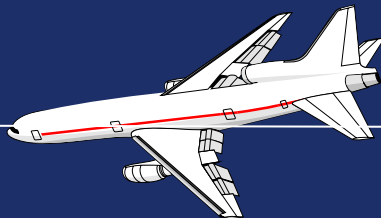
FL350



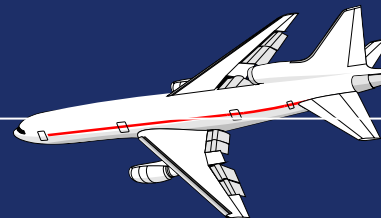
FL340



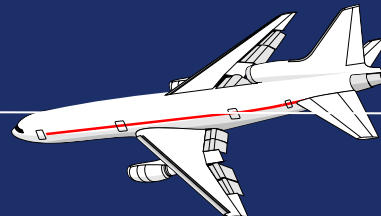
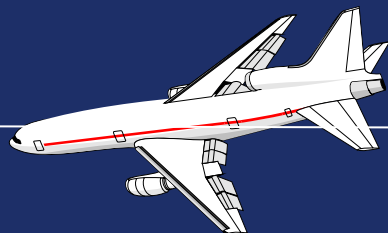
FL330



FL320



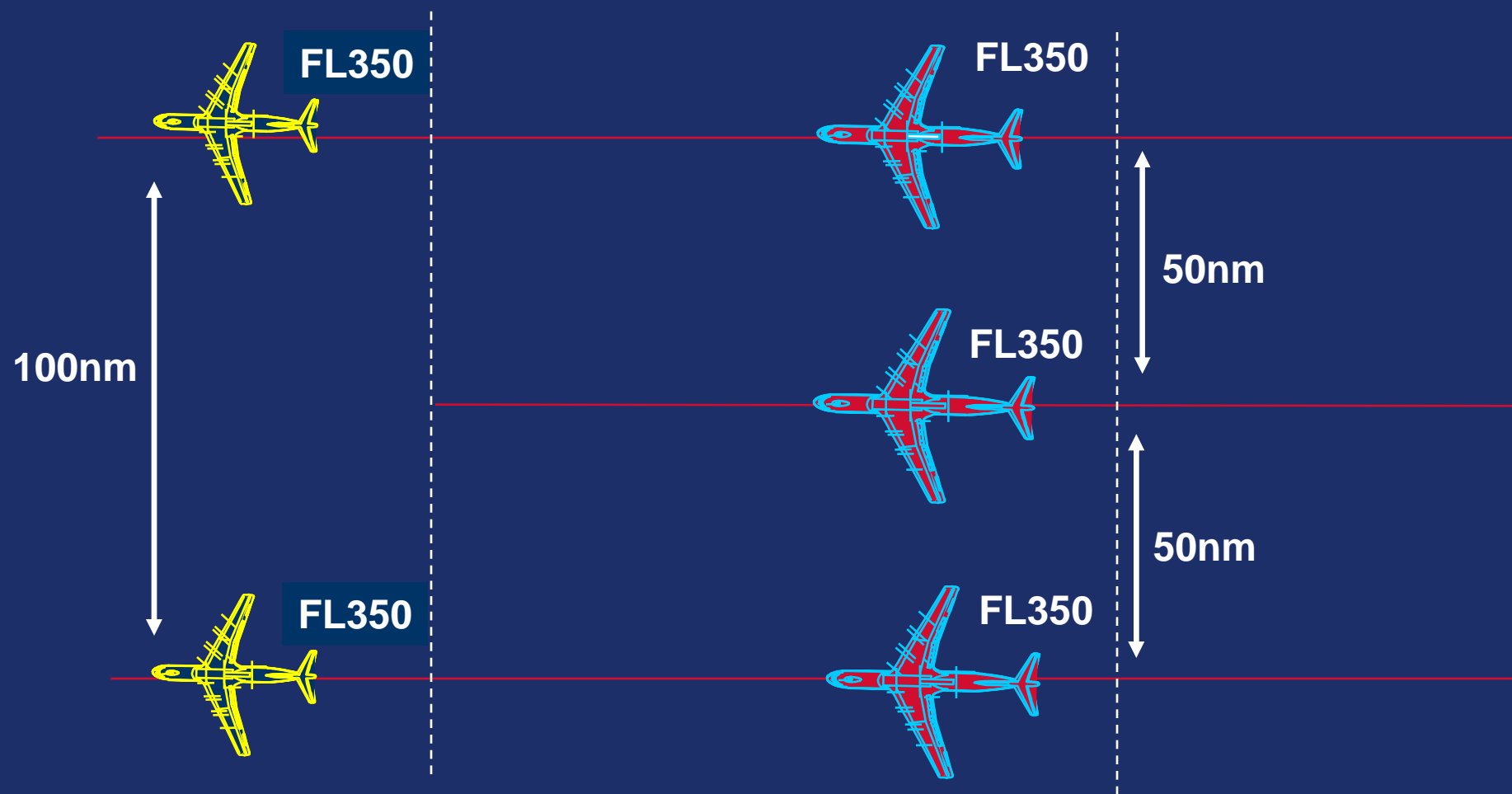
FL310



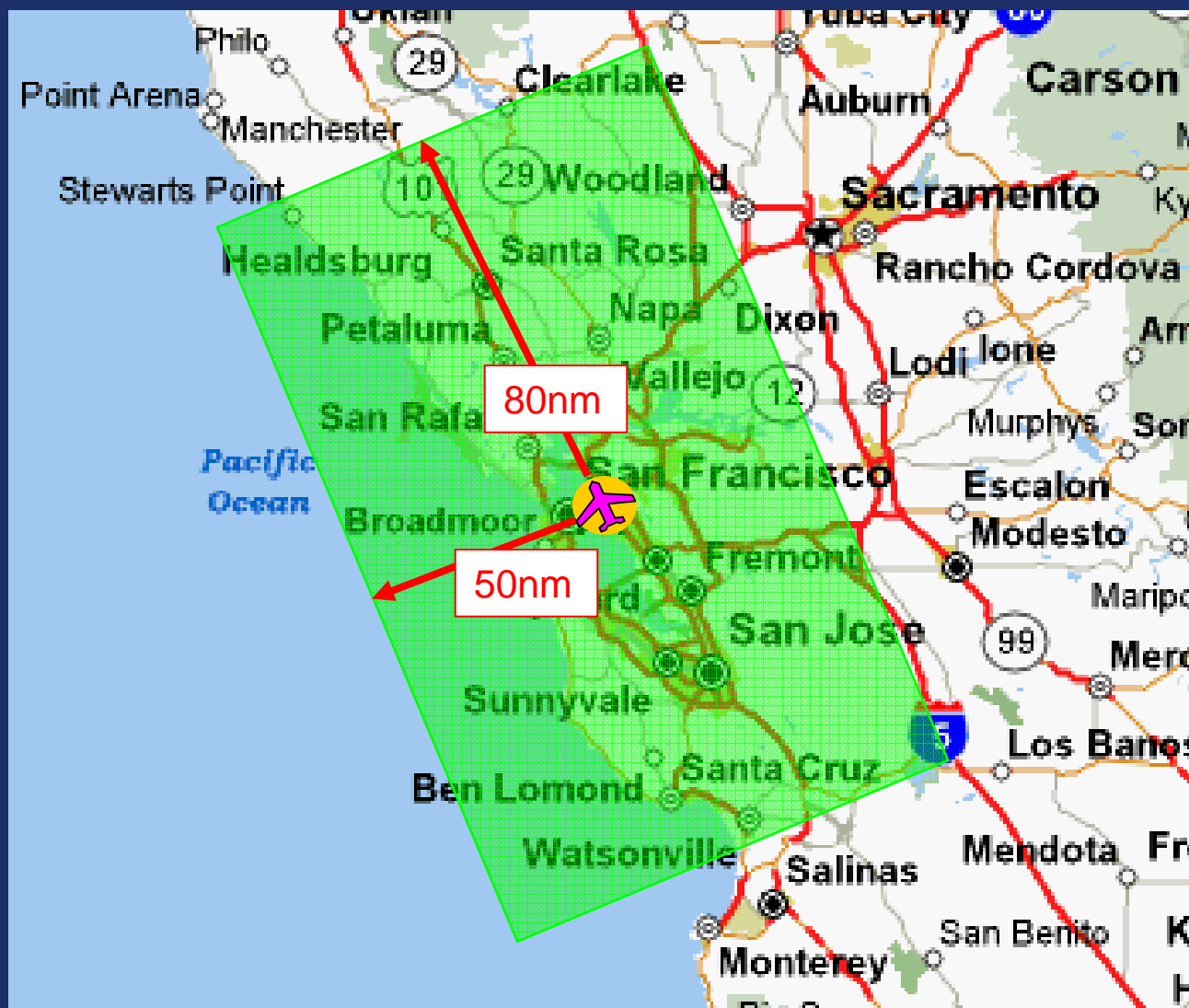
Required Navigation Performance (RNP 10)

- **Reduced Lateral Separation to 50NM**
- **Required on PACOTS and in the Central East Pacific**
- **Separation Reductions with More Precise Navigation**
- **Publication of more efficient routes generated closer to the wind core**
- **Increased airspace capacity**

STANDARD → RNP-10



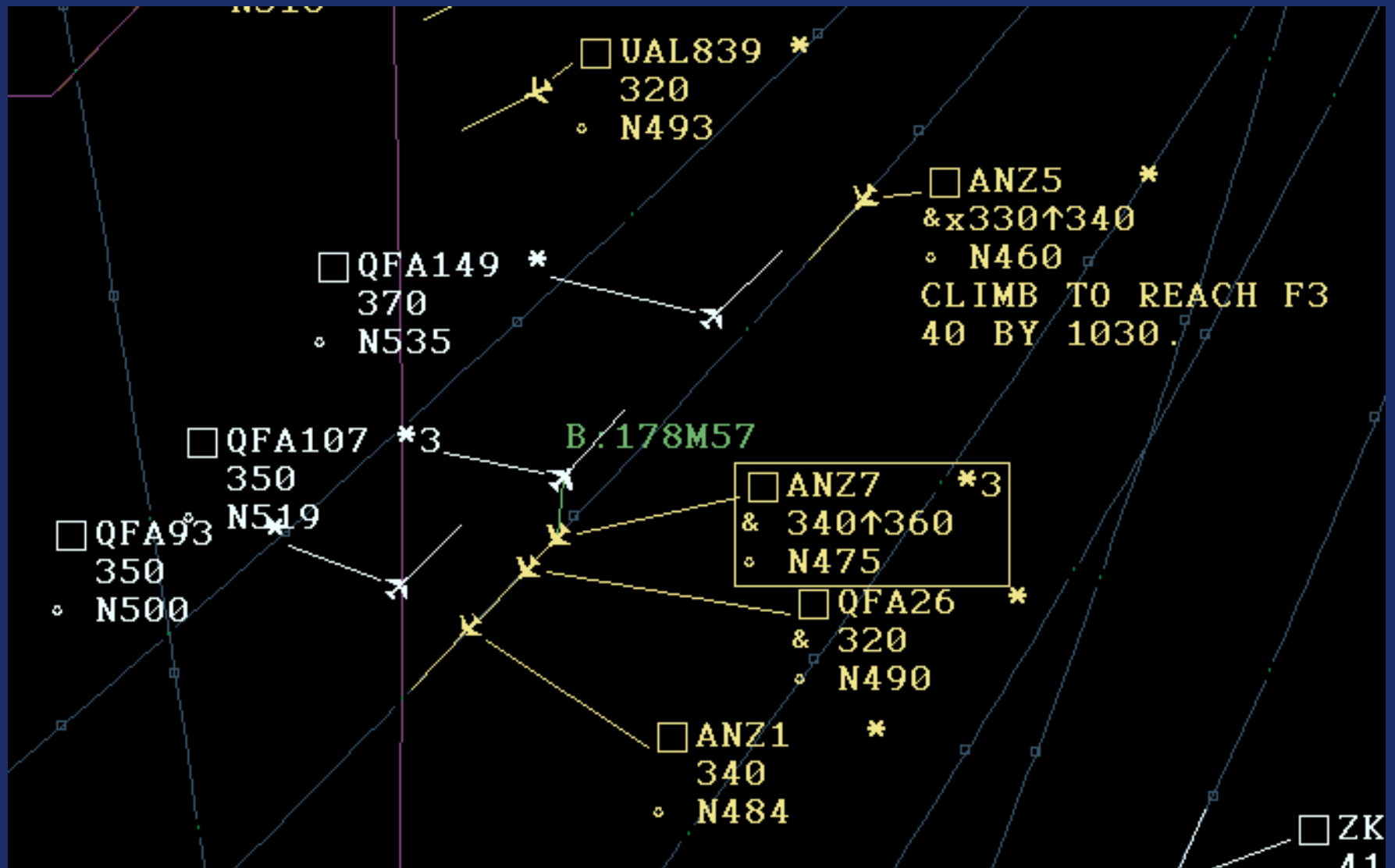
Oceanic Lateral Separation Comparison



Required Navigation Performance (RNP-4)

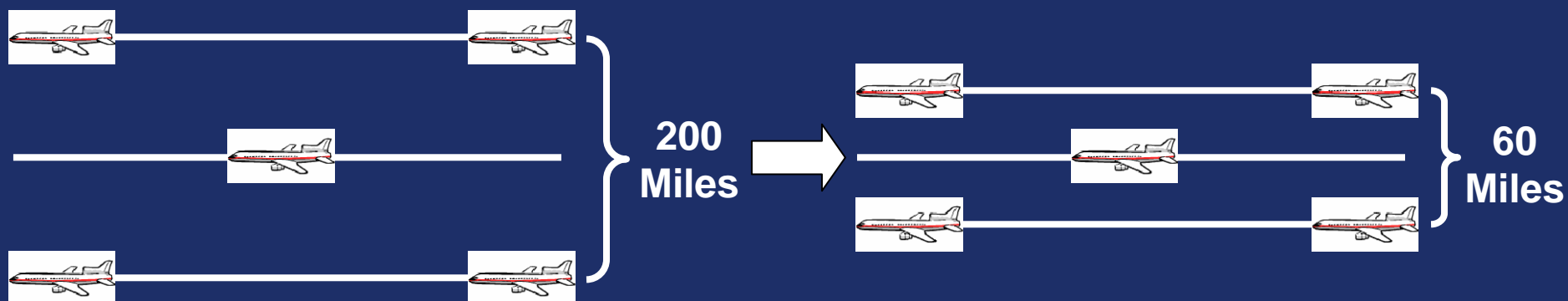
- **Reduced Lateral Separation to 30NM
between RNP4 certified datalink aircraft**
- **Separation Reductions with even more
Precise Navigation**
- **Increased airspace capacity**

RNP 4 ADS 30/30 Trials

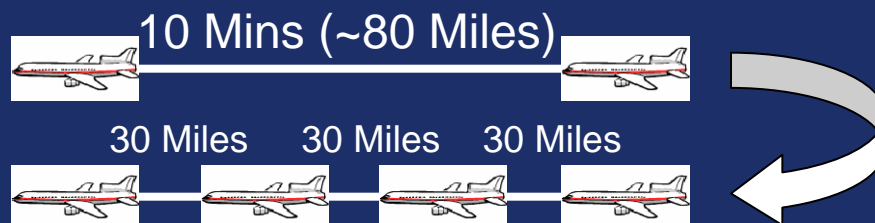


The ATOP System has Enabled Improved Airspace Efficiency and Capacity via Reduced Separation Standards

Lateral Separation

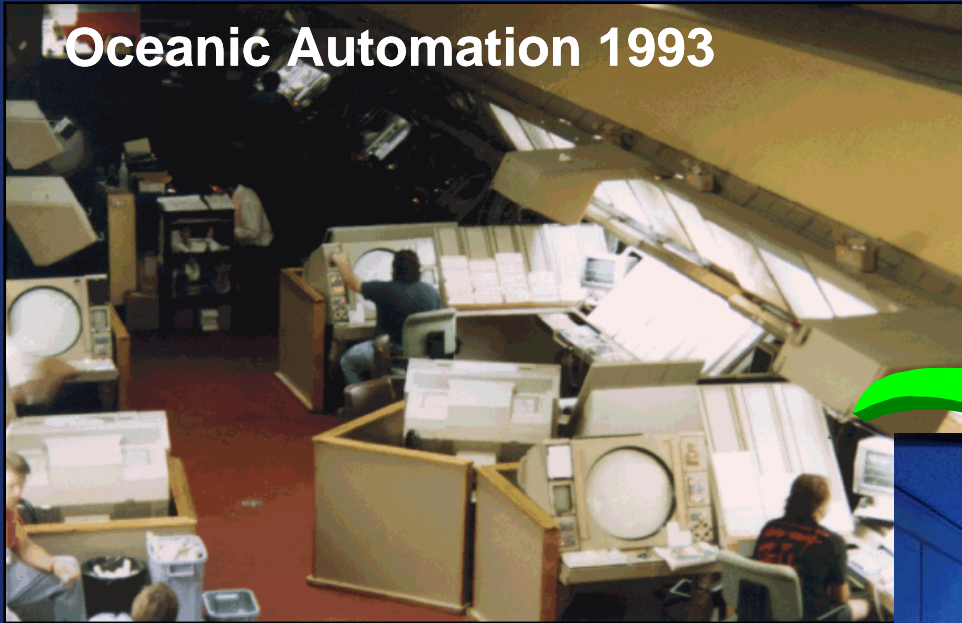


Longitudinal Separation



Oceanic Automation Evolution

Oceanic Automation 1993



Oceanic Display and Planning System





Ocean21 Oceanic Control System

ATOP Provides Integrated:

- Oceanic Flight Data Processing
- 4D Trajectory Modeling
- Automated Conflict Detection
- Controller Pilot Data Link Communication
- Automatic Dependent Surveillance - Contract
- ATS Inter Facility Data Communication
- Electronic Flight Strips (paperless environment)



Oceanic Control Position

Data Integration and Decision Support Tools

WORKSTATION DISPLAY

Intruder	Att	Active	Att	Ovrd	Type	StartTime	EndTime
*AAL5D	C:	NAR B4BN	-	>>	1004	1012	

CONFLICT REPORT

sane direction REQUIRED 10 minutes (50 nm) 1000 ft

19.0 degrees LOS NOM ACTUAL 3 min 22 sec (29 nm) 0 ft

B763	F310 ↑			5038N	4938N
AAL5D	F350			14350W	14423W
H083				1004	1012

B744	F350			5024N	4931N
UAlB4BD*	F350			14451W	14545W
H085				1004	1012

Close Help

Dat Of View | Search | HeadWind | Auto Insert | @

B763	5450N	5-NN	4622N	5950M	51N	2915N	2554N	CYFS HL
AAL5D	HRDM	310	14210W	14254W	14537W	14830W	15133W	PHNL F A R
E7	H085		0933	0940	1037	1130	1235	1249
			PHNL					
			1358					

B744	53N	4915N	43N	3952N	2607N	PHNL	CYFS HL
UAlB4OD*	HRBM	350	14150W	146W	15245W	15609W	PHNL F A R
E7	H085		0941	1014	1112	1141	1323

Draw Close

410 ABV
 400
 390
 380
 370

4001	B743		5026N	4735W	4420N	3604N	32N	2901N	2737N	CYFS YV
AAR12D	HRDM	370	12717W	13109W	13518W	14026W	144W	14724W	14907W	PHNL F A R
E7	H085		0919	0959	1051	1159	1216	1247	1302	
			2427N	PHNL						
			1534SW							

Electronic Flight Strips

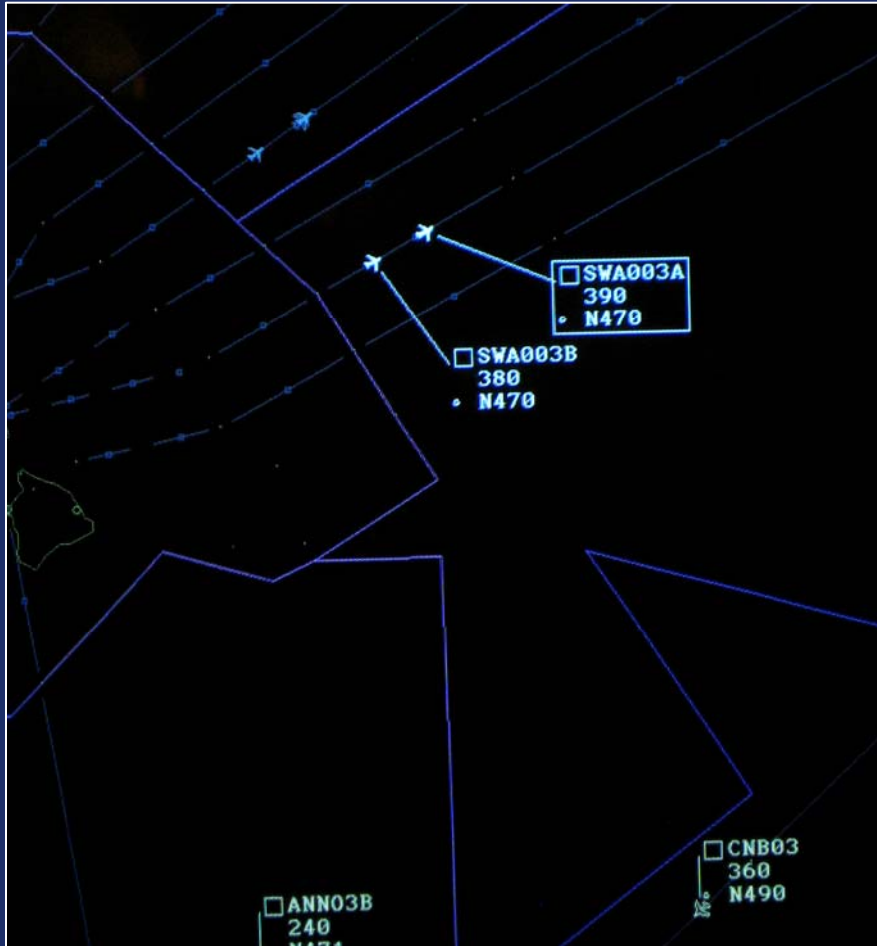
- *Single strip per flight*
- *System maintains strips*
 - *All critical data displayed*
 - *Automatically updated by position reports (HF, CPDLC, ADS)*
- *Controller alerted to significant changes*

3335	B744		NEONN	NANZA	6013N	NOLTI	NAYLD	NULUK	NATES	PANC	T
NWA113	MRDW	390			16835W					RJAA	N
3	M085		1953	2003	2005	2017	2026	2039	2130	R	
			NIKLL	NYMPH	NUZAN	NIPPI					
			2145	2150	2214	2239					

Color Coding for Significant Events and Indicators

Automatic ETA Updates

Automatic Dependant Surveillance-Contract (ADS-C)



- **ADS Contract established with aircraft**
 - Specifies Reporting Rate
 - What information to include
- **LDC, VDC and WPC also reported**

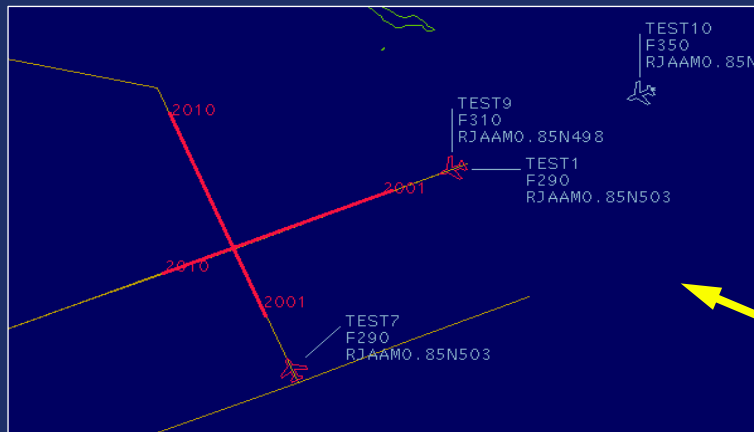
Aircraft Display Symbolology



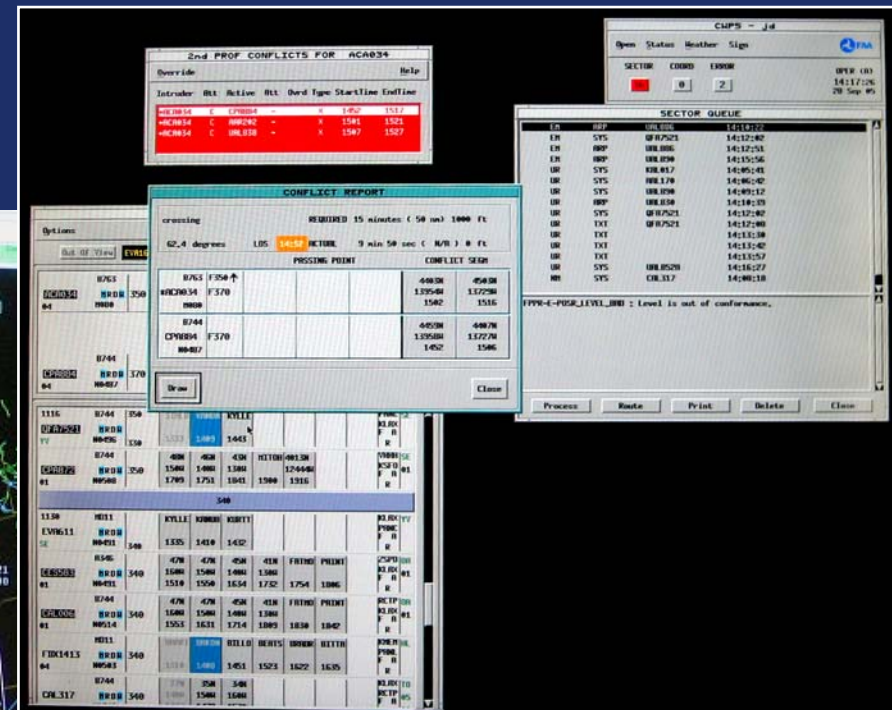
Ocean21 Conflict Probe

- System Finds Conflicts – Controller Resolves Conflicts
- Aircraft / Aircraft and Aircraft / Airspace
- Probe Runs Automatically on All Trajectory Updates
- Applies Appropriate Separation Standard
- System Enforces Pre-Delivery Trial Probe for All Clearances
- Controller Tools also Available

CONFLICT SUMMARY							
<u>Override</u>						<u>Help</u>	
Intruder	Att	Active	Att	Ovrd	Type	StartTime	EndTime
TEST8	-	TEST1	-	X		1901	1910



Conflict Report							
crossing		REQUIRED 15 minutes (50 nm) 1000 ft					
89 degrees	LOS	19:01	ACTUAL	3 min 12 sec	(49 nm)	0 ft	
PASSING POINT				CONFLICT SEGM			
B744				5843N	5948N		
TEST8	F290			17356W	17453W		
M085				1901	1910		
B744				5922N	5854N		
TEST1	F290			17245W	17454W		
M085				1901	1910		
Draw				Close			



Constructing ATC Clearances

CLEARANCE																	
UAL81C		7545N13343W 0614/ 52N15818W 0903/ 47N16209W 0940/ 3920N16754W 1043/ 3130N17354W 1149/ 2:															
Urgent	Rpt	Negot	Rspn	Misc	Vert	Route	Speed	X-ing	Conn								
RP	RR	CLIMB	@Time	@Fix	bTime	bFix	DSCND	@Time	@Fix	bTime	bFix	CROSS	A0A	A0B	NDA	HOLD	
20 CLIMB TO AND MAINTAIN (alt)		F310		EOS													
26 CLIMB TO REACH (alt)		F310		BY (time)				EOS									
27 CLIMB TO REACH (alt)		F310		BY (pos)				EOS									
(21) AT (time)		1045		CLIMB TO AND MAINTAIN (alt)		F300											INS
																	DEL
DL : REQUEST CLIMB TO F310																	
PRB	CAN	TPRB	SND	UNREL	VHF	SAVE	EALT	OVRD	COORD	RCPT	REJ	HLP	CLS				

Constructing ATC Clearances

CLEARANCE																
UAL81C		7545N13343W 0614/ 52N15818W 0903/ 47N16209W 0940/ 3920N16754W 1043/ 3130N17354W 1149/ 21														
Urgent	Rpt	Negot	Rspn	Misc	Vert	Route	Speed	X-ing	Conn							
RP	RR	climb ↑	@Time	@Fix	↳Time	↳Fix	DSCND	@Time	@Fix	↳Time	↳Fix	CROSS	XAOA	XAOB	NDA	HOLD
<div style="margin-bottom: 10px;"> 20 CLIMB TO AND MAINTAIN (alt) <input type="text" value="F310"/> <input type="button" value="EOS"/> </div> <div style="margin-bottom: 10px;"> 26 CLIMB TO REACH (alt) <input type="text" value="F310"/> BY (time) <input type="text"/> <input type="button" value="EOS"/> </div> <div style="margin-bottom: 10px;"> 27 CLIMB TO REACH (alt) <input type="text" value="F310"/> BY (pos) <input type="text"/> <input type="button" value="EOS"/> </div> <div style="margin-bottom: 10px;"> (21) AT (time) <input type="text" value="1045"/> CLIMB TO AND MAINTAIN (alt) <input type="text" value="F300"/> </div>																
															<input type="button" value="INS"/> <input type="button" value="DEL"/>	
DL : REQUEST CLIMB TO F310																
<input type="button" value="PRB"/>	<input type="button" value="CAN"/>	<input type="button" value="TPRB"/>	<input type="button" value="SND"/>	<input type="button" value="UNREL"/>	<input type="button" value="VHF"/>	<input type="button" value="SAVE"/>	<input type="button" value="EALT"/>	<input type="button" value="OVRD"/>	<input type="button" value="COORD"/>	<input type="button" value="RCPT"/>	<input type="button" value="REJ"/>	<input type="button" value="HLP"/>	<input type="button" value="CLS"/>			

2nd PROF CONFLICTS FOR ACA034							
Override							Help
Intruder	Rtt	Active	Rtt	Ovrd	Type	StartTime	EndTime
*ACA034	C	CPH004	-		X	1452	1517
*ACA034	C	RRR242	-		X	1501	1521
*ACA034	C	URL030	-		X	1507	1527

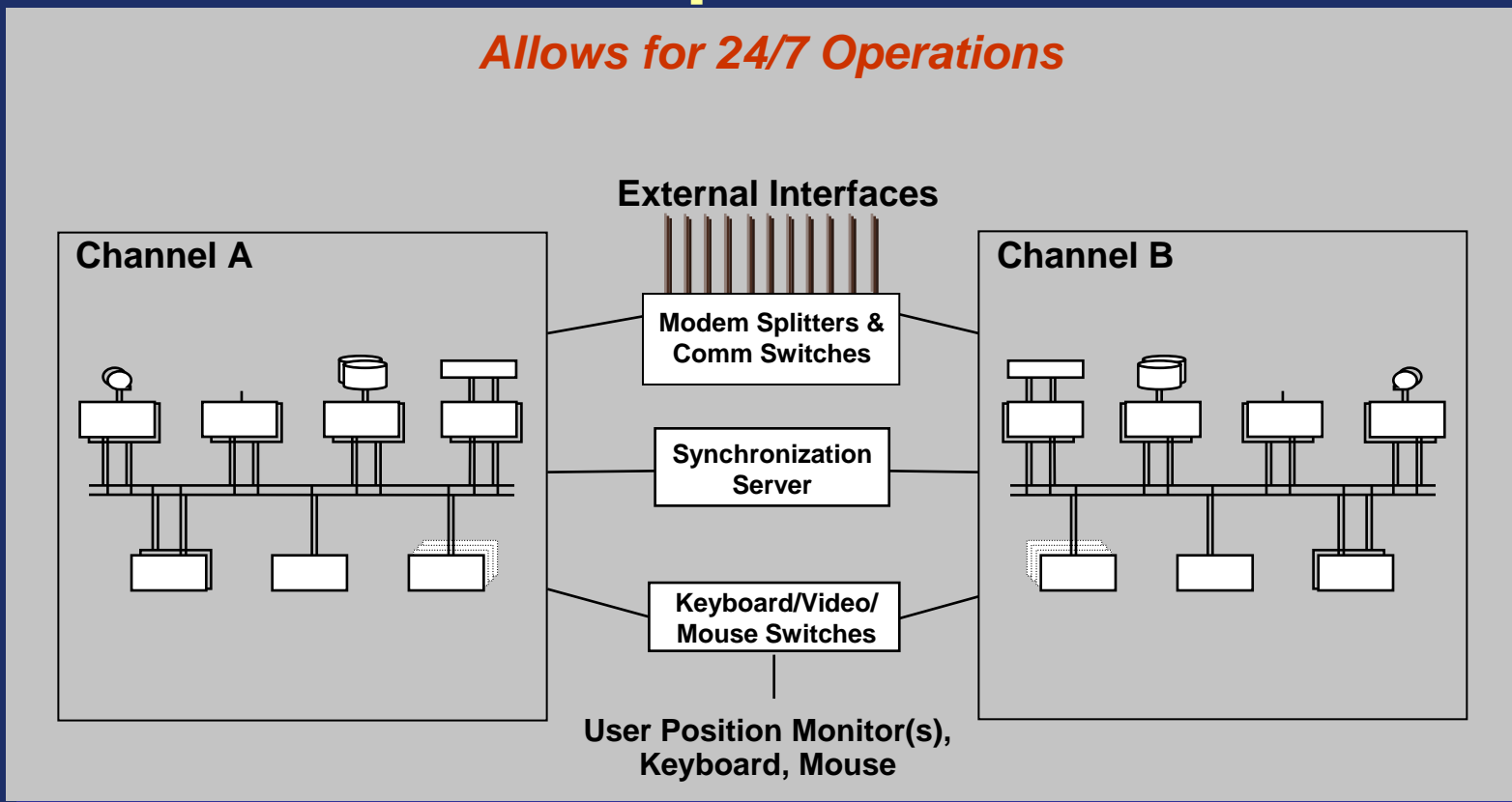
CONFLICT REPORT					
crossing		REQUIRED 15 minutes (50 nm) 1000 Ft			
62.4 degrees	L05	14:52	ACTUAL	3 min 50 sec (N/B) 0 Ft	
PASSING POINT			CONFLICT SEGM		
0763	F350 ↑			4403N	4503N
0700034	F370			13954N	13729N
0800				1452	1516
0744				4453N	4407N
0700004	F370			13958N	13727N
0807				1452	1506

Draw
Close

1333	1409	1443					KLEX F R	SE
43N	45N	45N	MITO	4013N			1000 KSF0 F R	01
1504	1404	1304		124444			R	
1709	1751	1841	1900	1916				
340								
1335	1410	1432					KLEX P00C F R	TV
47N	47N	45N	41N	FATH	PRINT		ZSPD KLEX F R	01
1504	1504	1404	1304					
1510	1550	1634	1732	1754	1806			
47N	47N	45N	41N	FATH	PRINT		ACTP KLEX F R	01
1504	1504	1404	1304					
1553	1631	1714	1809	1830	1842		R	
1000	1000	BILLO	BEATS	BRNOR	BITTA		100N P00C F R	HL
1310	1400	1451	1523	1622	1635		R	
37N	35N	34N					KLEX ACTP F R	TO 45

Ocean21 Equipment Capabilities: Two Channel Concept

Allows for 24/7 Operations



Scheduled Maintenance accounts
for approximately 98% of system
downtime in En Route environment

In event of Catastrophic Failure
the system will automatically
print paper strips

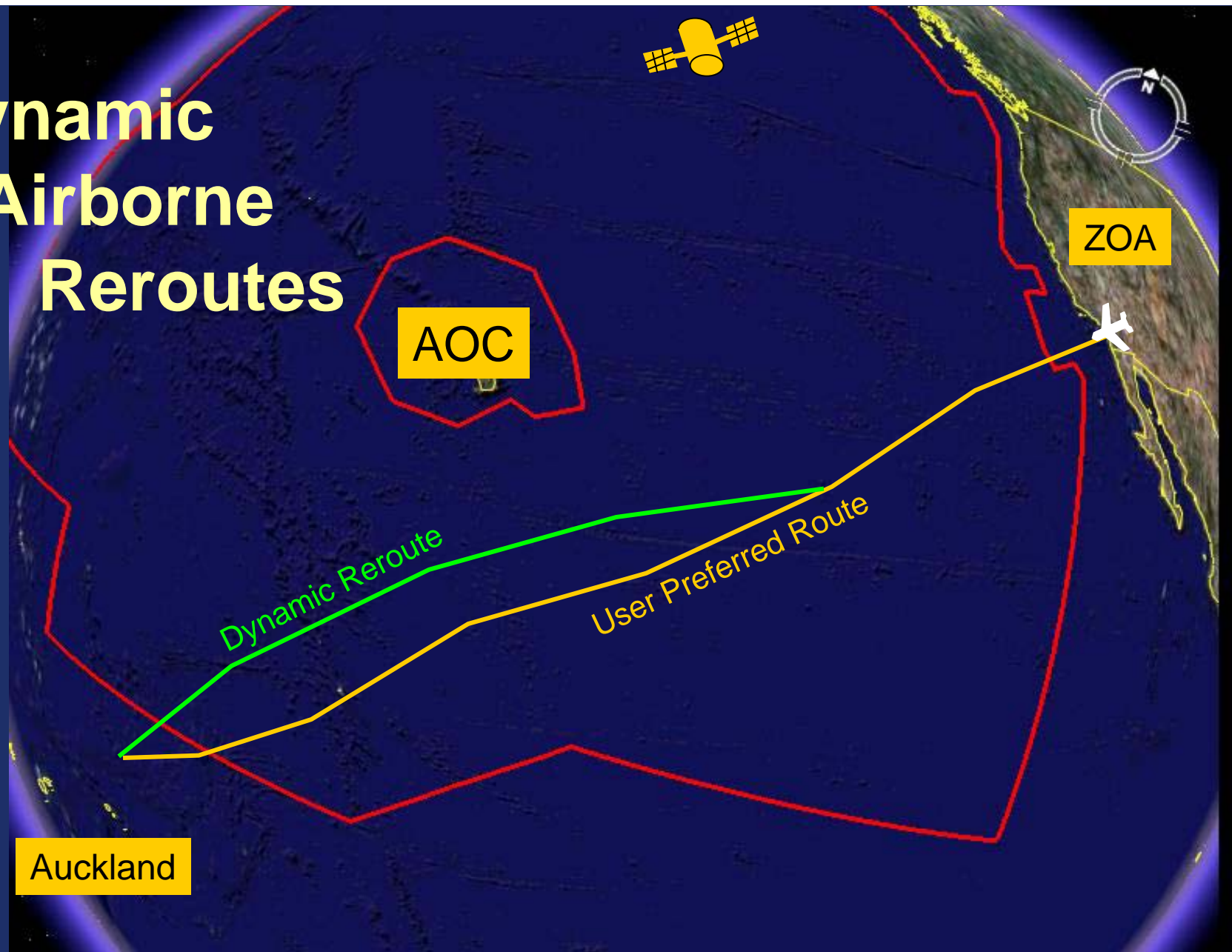
ATS Interfacility Data Communication (AIDC)

- **Operational since 1998**
- **Automated Flight Data Transfer**
- **Eliminates/Reduces Verbal Coordination**
- **In use with Anchorage, Nadi, Fukuoka and Auckland ACC.**
- **Capability Exists to Connect to Additional Facilities**

AIDC Benefits

- **Decreased controller workload therefore increased service to the users**
- **Eliminates transcription errors**
- **Automatically activates flight plans and updates flight plan information**

Dynamic Airborne Reroutes



The aircraft files an ICAO Flight Plan (FPL) and sends it via AFTN to each of the affected control facilities.

This is usually accomplished by the Airline Operations Center (AOC)

1. ICAO model flight plan form

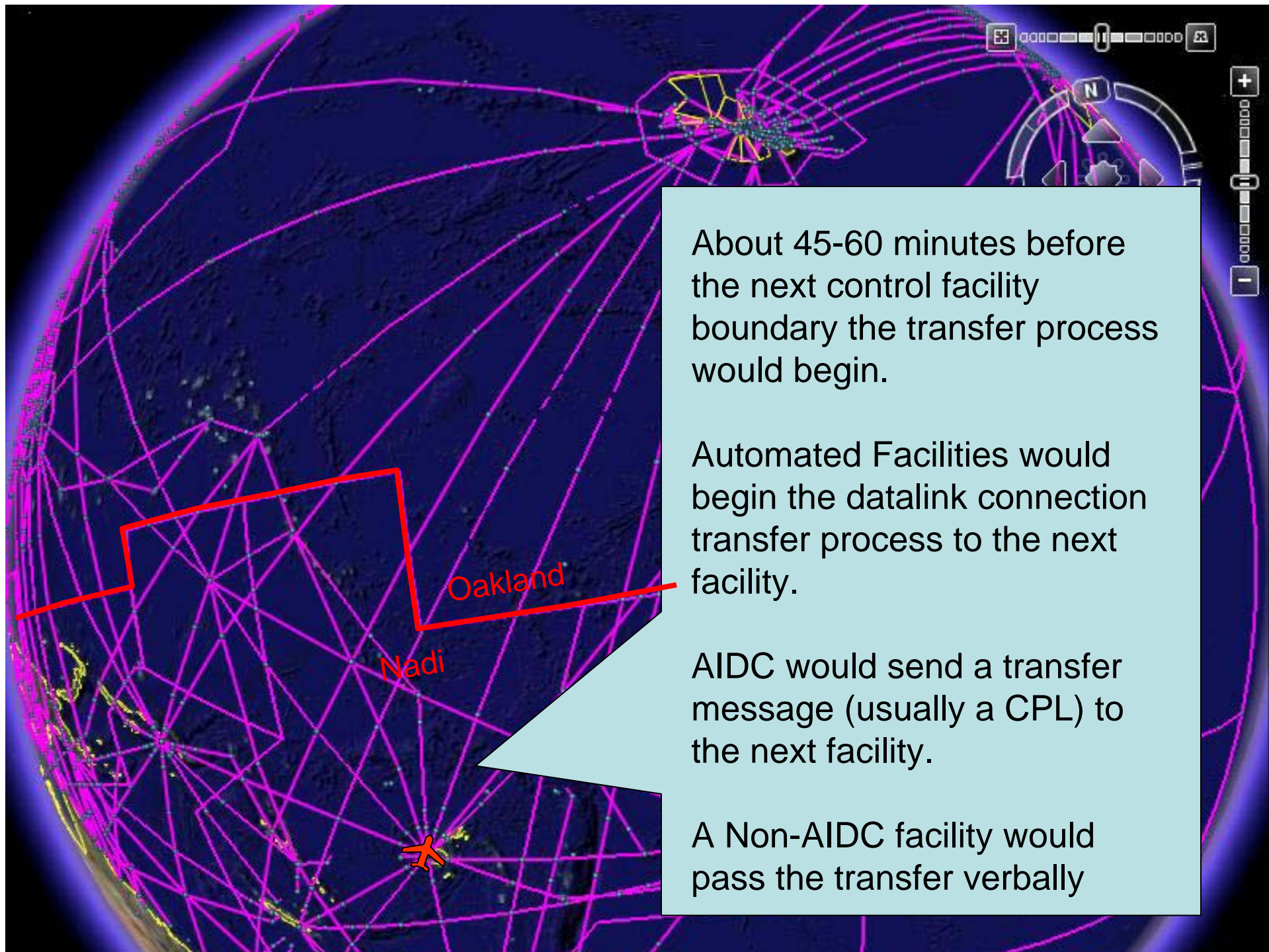
FLIGHT PLAN PLAN DE VOL	
PRIORITY Priorité <<= FF =>	
ADDRESS(ES) Destinataire(s)	
FILING TIME Heure de dépôt	
ORIGINATOR Expéditeur	
SPECIFIC IDENTIFICATION OF ADDRESS (S) AND/OR ORIGINATOR Identification précise du (des) destinataire(s) et/ou de l'expéditeur	
3 MESSAGE TYPE Type de message <<= (FPL)	7 AIRCRAFT IDENTIFICATION Identification de l'aéronef
4 NUMBER Numéro	8 FLIGHT RULES Règles de vol
5 TYPE OF AIRCRAFT Type d'aéronef	9 NAME TURBULENCE CAT. Cat. de turbulence de sillage
10 DEPARTURE AERODROME Aéroport de départ	11 EQUIPMENT Équipement
12 COURSE SPEED Vitesse courue	13 LEVEL Niveau
14 ROUTE Route	15 TIME Heure
16 DESTINATION AERODROME Aéroport de destination	
17 OTHER INFORMATION Renseignements divers	
TOTAL SET Sans totale et finale NO. MSG.	
ALTN AERODROME Aéroport de dépaysement	
2ND ALTN AERODROME 2 ^e aéroport de dépaysement	
SUPPLEMENTARY INFORMATION (NOT TO BE TRANSMITTED IN FPL MESSAGE) Renseignements complémentaires (à ne pas transmettre dans les messages de plans de vol déposés)	
18 DEBRANDS Adresses E / HE MH	
PERSONS ON BOARD Personnes à bord P /	
EMERGENCY RADIO Radio de secours R / U V E	
JACKET/Side of coverage J / L F U V	
NUMBER Numéro D /	
CAPACITY Capacité C /	
COVER Couverture COLOUR Couleur	
AIRCRAFT COLOUR AND MARKINGS Couleur et marques de l'aéronef A /	
REMARKS Remarques N /	
FLIGHT COMMENTS Commentaires de vol C /	
FILED BY / Déposé par	
SPACE RESERVES FOR ADDITIONAL REPERMISSEMENTS Espace réservé à des fins supplémentaires	



(DEP-QFA444-NFFN1923-PHNL)

The aircraft would receive an ATC IFR clearance from the responsible ATC facility.

When the aircraft departs, the responsible facility transmits an ICAO Departure Message (DEP) via AFTN to the affected facilities



About 45-60 minutes before the next control facility boundary the transfer process would begin.

Automated Facilities would begin the datalink connection transfer process to the next facility.

AIDC would send a transfer message (usually a CPL) to the next facility.

A Non-AIDC facility would pass the transfer verbally

SECTOR QUEUE

UR	TXT	10:06:27
UR	TXT	10:06:29
un	TXT	10:06:33
		10:08:42
		10:11:47
		10:12:07

INIT_REQ : [DAL2C]: Initial
[CPL-DAL2C-IS
5N17805E 3452N16800E

COORDINATION

Requested Coordination

DAL2C

FPCT-I-FREE_FORMAT_INF : FPCT-I-COOR_INIT_REQ : [DAL2C]: Initial Coordination is required with [ZN] :
[CPL-DAL2C-IS

Planned

FIX	TIME	ROUTE
4925N17805E	1122	
3452N168E	1320	

COORD FIX

ETA

OFF/DEV

MACH

4925N17805E

1122

CLR FL

BLK

XING

DIR

F310

CRS FL

SPEED

DEST

F310

M085

RJAA

ROUTE

6220N17024W 57N178W 4925N17805E
3452N16800E

MESSAGES

CANCEL PROBE

Proposed by "ZN"

FIX	TIME	ROUTE
4925N17805E	1122	
3452N168E	1321	

COORD FIX

ETA

OFF/DEV

MACH

4925N17805E

1122

CLR FL

BLK

XING

DIR

F310

CRS FL

SPEED

DE

F310

M085

R

ROUTE

6220N17024W 57N178W
3452N16800E

ZN >

Proposed by "01"

FIX	TIME	ROUTE

AIRCRAFT MESSAGES

NM	ACP	DAL2C	10:23:28
NM	POS	CDN3B	10:22:04
NM	POS	CDN3D	10:22:03
NM	POS	CDN3E	10:19:02
NM	POS	CDN5D	10:18:27
NM	POS	CDN3A	10:15:02

Origin.....: <>
Destination: <PAZAZQZX>.

<ACP-DAL2C-PAFM-RJAA>

Acid :
Date from :
Time from :
Message Type :
Date to :
Time to :

Search

Print

Route

Close

DAL2C

Accept

Reject

Negot

Outgoing Message

Manual

Send

Open Cl

SECTOR QUEUE

NM	TOC	AAR62C	10:07:44
NM	CPD	QFA1C	10:08:04
NM	CPD	ANA811C	10:08:12
NM	REQ	AN253C	10:08:22
NM	REQ	CHI69C	10:08:32
NM	CPD	UAL852C	10:08:42

DL : REQUEST CLIMB TO F370

Process Route

CLEARANCE

QFA1C 1641N15009E 0716/ 2146N15720E 0812/ 2707N16403E 0905/ 3028N168E 0937/ 3352N17150E 1012/

Urgent	Rpt	Negot	Rspn	Misc	Vert	Route	Speed	X-ing	Conn							
RP	RR	climb	@Time	@Fix	@Time	@Fix	DSCND	@Time	@Fix	@Time	@Fix	CROSS	AOA	AOB	NDA	HOLD

20 CLIMB TO AND MAINTAIN (alt) F370 EOS

26 CLIMB TO REACH (alt) F370 BY (time) EOS

27 CLIMB TO REACH (alt) F370 BY (pos) EOS

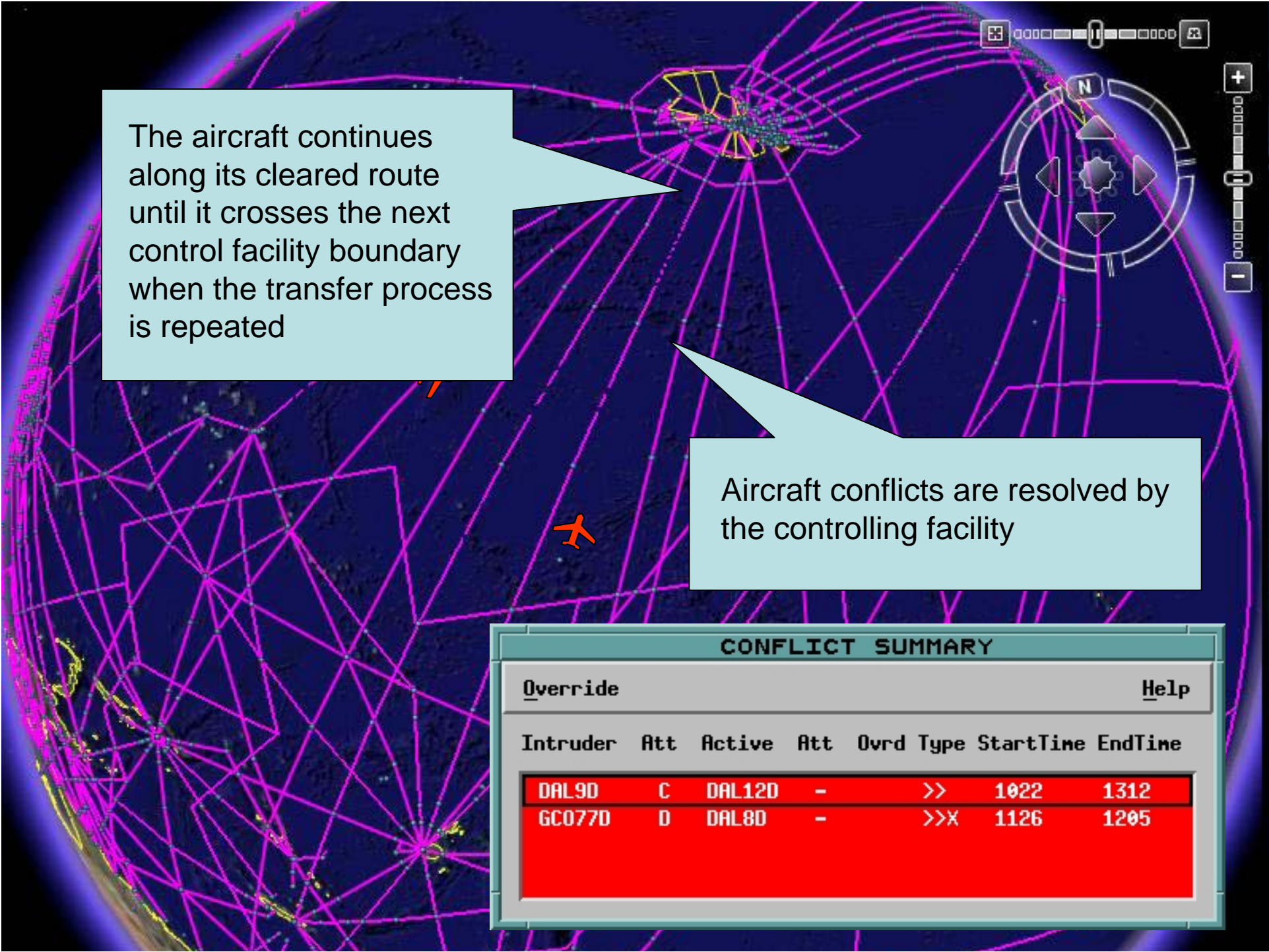
INS
DEL

DL : REQUEST CLIMB TO F370

PRD CAN TPRB SNO UNRDL VHF SAVE EALT DVRO COORD RCPT REJ HLP CLS

boundary.

Any aircraft requests are handled by the controlling facility.



The aircraft continues along its cleared route until it crosses the next control facility boundary when the transfer process is repeated

Aircraft conflicts are resolved by the controlling facility

CONFLICT SUMMARY

Override

Help

Intruder	Att	Active	Att	Ovrd	Type	StartTime	EndTime
----------	-----	--------	-----	------	------	-----------	---------

DAL90	C	DAL120	-	>>		1022	1312
-------	---	--------	---	----	--	------	------

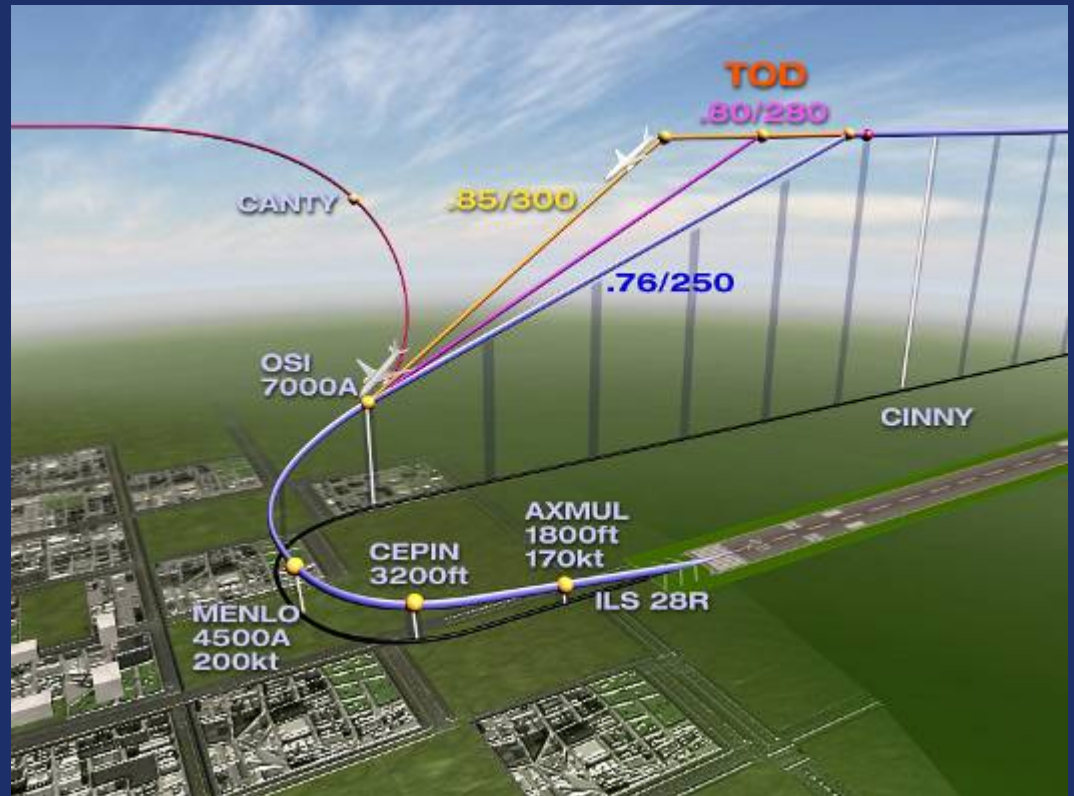
GC0770	D	DAL80	-	>>X		1126	1205
--------	---	-------	---	-----	--	------	------

Automatic Dependent Surveillance-Broadcast (ADS-B)

- The **ADS-B** is a system being evaluated by the FAA and airlines, that takes advantage of improved accuracy signals from GPS to allow aircraft to automatically broadcast their location to ground-based receivers.
- ADS-B is seen on traffic displays by ATC and can be simultaneously received by other ADS-B equipped aircraft.
- The update rates and accuracies, in initial tests, exceed those of radar.

San Francisco OTA Trials

- OTA trials were conducted for SFO oceanic arrivals during 2007 in an FAA, Boeing and NASA partnership
- SFO trials indicated significant emissions reduction and noise abatement
- The FAA and partners are evaluating SFO trial results and assessing expansion of SFO trials during 2008
- Additional trials are being planned as part of the AIRE Program for a US East Coast destination such as Miami



Oceanic Controller Training

- **FAA Academy (Oklahoma City) - 11 weeks**
 - Fundamentals of aviation and ATC
 - Classroom and simulation labs
- **Field Facility – typically 3 years to CPC**
 - Classroom (local airspace and procedures)
 - Assistant controller
 - Controller Training
 - Simulation lab (DYSIM) -
 - On the Job Training (OJT)



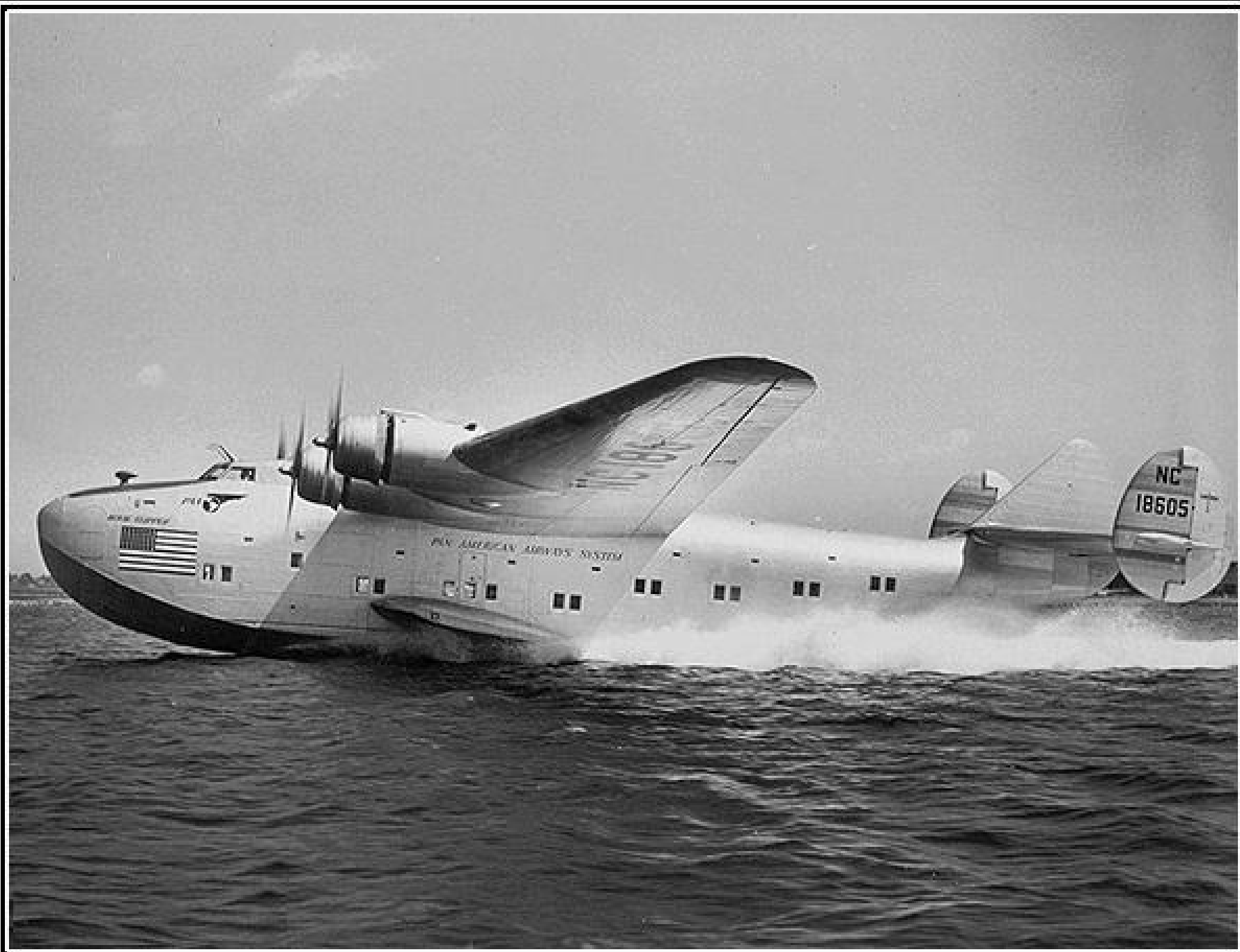
HAWAII BY FLYING CLIPPER



PAN AMERICAN AIRWAYS SYSTEM









Ames Research Center
September 5-6, 2007



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Oceanic Dining Club 02



PILOT'S INSTRUMENT PANEL 314 11161-B F-13-39



It is a small world... by Pan American

AMERICA'S MERCHANT MARINE OF THE AIR

Look at the world as it is, and you will find it a small world. It is the fact that the world is so small that it is possible to travel from one end of the world to the other in a matter of days. This is the fact that the world is so small that it is possible to travel from one end of the world to the other in a matter of days. This is the fact that the world is so small that it is possible to travel from one end of the world to the other in a matter of days.

Think what this means for the world. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days.

It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days.

no international travel means a privilege that has been lost in this country since the days of old.

Yet, the world is so small that it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days.

Pan American speeds passengers, merchandise and mail between nearly 100 points, making connections with other transportation lines to Australia

and Japan. Pan American planes have been a primary means of transportation since the days of old. It means a world where it is possible to travel from one end of the world to the other in a matter of days. It means a world where it is possible to travel from one end of the world to the other in a matter of days.

Whether you live in America, a Pan American airport is quickly accessible. You can get passenger facilities and travel agents in transportation lines, express information at any Railway Express office or mail box at any time after... and all this in any Pan American office.

Whether you want to see interesting lands, reach new markets with pleasure and convenience, or give wings to your ideas, the Flying Clippers are ready. They have shortened travel time in days, and ship to home. Truly, it is a small world today... by Pan American. **WORLDWIDE**







FLY TO SOUTH SEA ISLES



Via **PAN AMERICAN**







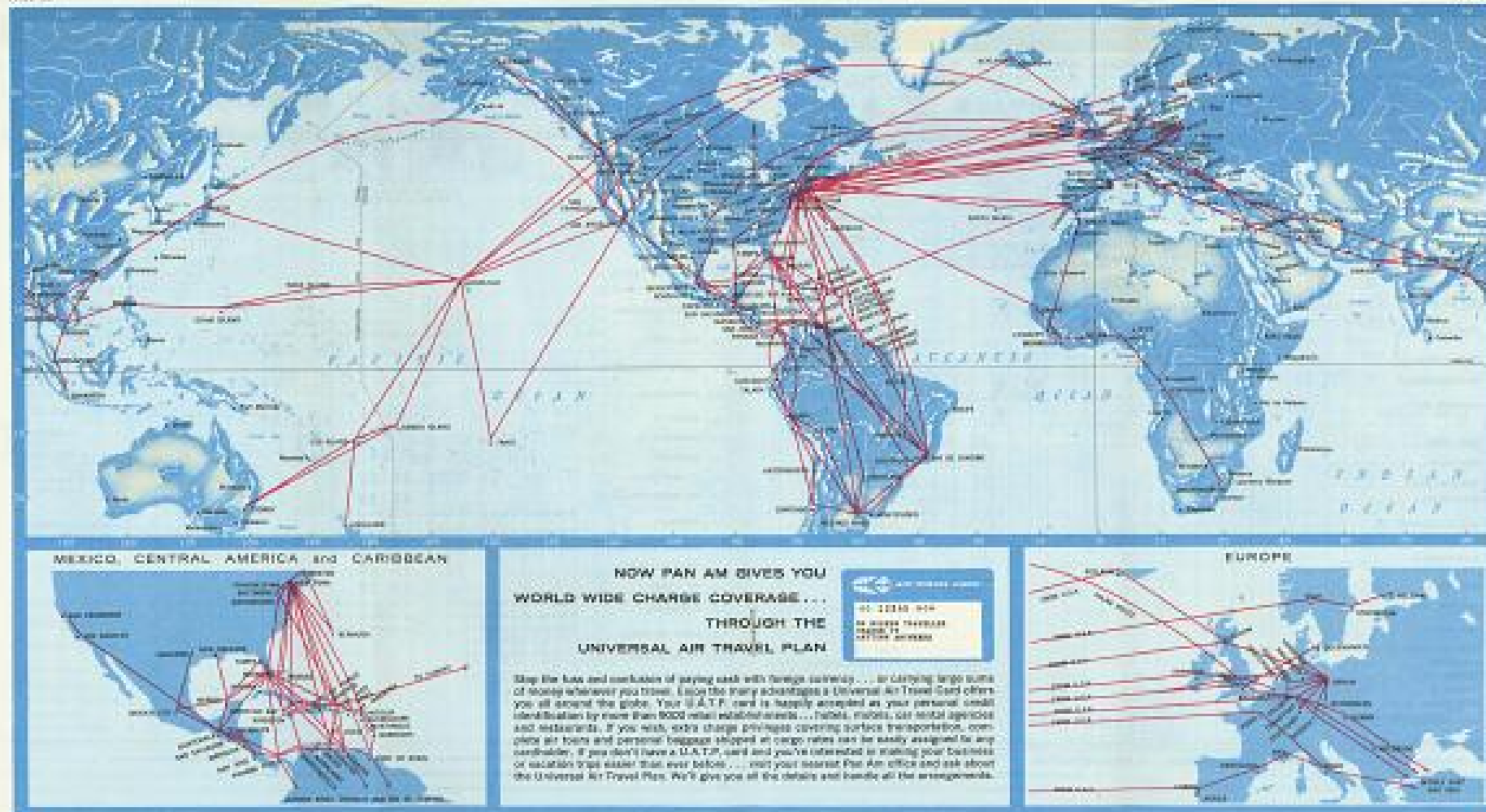




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Oceanic Boeing slide 67



September 3-6, 2007







